

COMPLEX MALE PREMATING STRIDULATION OF THE
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ABSTRACT

Male *Hylurgops rugipennis* infesting Sitka spruce have a multi-pulse stress chirp and bimodally patterned premating stridulation, but they do not produce the bimodal pattern of stridulation in response to attractive frass in the absence of the female. Males do not have rivalry stridulation; females do not emit multi-pulse chirps.

INTRODUCTION

Hylurgops rugipennis (Mann.) (Scolytidae) is a western species occurring from Alaska to central California that infests various conifers, including pine and spruce (Swaine 1918; Chamberlin 1939). The beetles are stout, 4-5 mm in length, red dorsally, usually black ventrally (Swaine 1918) and monogamous. Adults prefer the shaded underside of fallen trees, occurring densely enough to be competitive with *Dendroctonus rufipennis* (Kirby) on Sitka spruce, *Picea sitchensis* (Bong.) Carr. (Rudinsky *et al.* 1974).

Barr (1969) described the stridulatory apparatus of *H. rugipennis* as the elytral-abdominal type and stated that the male stridulates during entry into the female's gallery. However, the details of pair formation and stridulation have not been described. Besides the well-known stress chirping response of males of monogamous bark beetles, "attractant" chirps have been described for males responding to attractant pheromones in the frass of unpaired females (Rudinsky and Michael 1972). An additional "pre-mating" chirp is known in *Dendroctonus pseudotsugae* Hopkins as the male responds directly to the female, and before male "courtship" stridulation (Rudinsky and Ryker 1976, Ryker and Rudinsky 1976). Aggressive behavior between monogamous males in the same female gallery may also include "rivalry" stridulation (Rudinsky and Michael 1974). Stridulation of *H. rugipennis* was studied in the above-mentioned behavioral contexts. Described for the first time in Scolytidae is an acoustic "sentence" produced by the male during pairing with a female in her gallery.

METHODS AND MATERIALS

Beetles were collected while they were infesting recently felled Sitka spruce in April 1975 and 1977 near Otis, Oregon. The beetles were sexed according to the presence of a plectrum in males (Barr 1969) and stored at 4°C until needed.

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Stridulatory organs of 10 males were dissected, affixed to a microscope slide, and measured by viewing through a compound microscope fitted with a Filar 424C micrometer. Areas of cuticle on females that had stridulatory organs in males were also examined.

Pairing behavior was studied in the laboratory, and we attempted to pinpoint the stimuli responsible for male stridulation in the entry to the female gallery. Copulation was not observed. Females were placed under gelatin capsules on the bark of fresh spruce logs and allowed to bore for 2 days to provide attractive galleries for testing. Stridulation was studied during pairing by placing a male 5 cm from a boring female such that the male would walk to the gallery entry between 2 glass slides placed on their long edges as guides. Pairing behavior was observed; stridulation was tape recorded for 5 pairings and monitored with earphones on an additional 37 pairings. To determine if the female's frass alone was requisite stimulus for the male chirping response during pairing, 38 males were tested for acoustic response while walking to holes drilled in the bark of fresh spruce logs. The same number of males was tested walking to drilled holes containing frass just taken from galleries of virgin females.

Intra- and intersex behavior was observed during colonization of spruce logs in the forest in 1975 and 1977. Spacing of attacks and possible aggressive or territorial behavior was studied. Interactions between resident and intruding males in 43 female galleries on field attacked logs were studied in the laboratory for possible rivalry behavior. A male (intruder) was placed into each gallery containing a paired female and resident male. Sounds were tape recorded during 10 trials. Chirp parameter sample means (number of toothstrikes, toothstrike rate, chirp duration) of premating chirps were compared to stress chirps statistically by analysis of variance and Scheffé's test (Snedecor and Cochran 1967, p. 271) and depended on 30 sampled chirps, 6 per each of 5 males. Stress chirps were recorded by holding each male or female beetle between thumb and forefinger 0.5 cm from the microphone.

Acoustic signals were recorded with a Hewlett Packard Model 15119A condenser microphone, a PAR Model 113 low noise preamplifier with the bandwidth set at 0.3-100 kHz and a Nagra 4.2L tape recorder. The recording system had an essentially flat measured frequency response from 0.02-22 kHz at a tape speed of 38 cm/sec. Oscillograms were Polaroid photographs of sounds displayed on a Tektronix model 5103N storage oscilloscope. The carrier frequency of male stridulation was measured with a Kay Sona-Graph 6061A.

RESULTS AND DISCUSSION

The mean length of the elytral file (*pars stridens*) of male *Hylurgops rugipennis* is 0.52 ± 0.01 mm (\pm SE) with an average of 155 ± 3 teeth (138-174, $n = 10$). The female has a similar file, but lacks the 2-pronged plectrum found on the male 7th abdominal tergite. Females could not be induced to produce multi-pulse chirps, although they may have emitted the intense clicks heard during pair formation. Male chirps had a broad band of frequencies, most intense between 1-12 kHz, and less intense up to 18 kHz.

In the laboratory males were attracted into galleries of unpaired females, and began chirping when the female was contacted. At male contact, most females responded by backing towards the gallery entrance, forcing the male to back out first. While backing out, the male usually stridulated repeatedly, brushed his antennae across the female's elytra, and stroked her elytra with his pro- and mesothoracic legs. The male's head was lowered and directed toward the female. Once outside the gallery some males left the posterior position to circle around the protruding female. The pairs entered or re-entered the galleries within 5-20 min., after which stridulation diminished or ceased entirely.

Males were tested with freshly drilled artificial galleries with and without frass present to see if frass was sufficient stimulus for the male stridulation response. Males explored and entered holes, but were generally silent in vacant holes. Although 26% chirped in frass-filled holes without females, chirping males did not produce typical premating stridulation (Table 1).

Table 1. Acoustic response of male *Hylurgops rugipennis* when entering natural and artificial galleries in Sitka spruce logs

| Situation | No. trials | Number of males chirping | | |
|----------------------|------------|--------------------------|----------------|----------|
| | | Simple chirps | Bimodal chirps | Σ |
| vacant hole | 38 | 3 | 0 | 3 |
| same + frass | 38 | 10 | 0 | 10 |
| gallery w. ♀ + frass | 42 | 1 | 41 | 42 |
| same w. ♂♀ pair | 43 | 3 | 0 | 3 |

Table 2. Summary of sound parameter measurements for *Hylurgops rugipennis*

| Stridulation | Toothstrikes | Duration | Toothstrike Rate |
|-----------------|-------------------------------|-------------------------------|-------------------------------|
| | $\bar{x} \pm 95\% \text{ CI}$ | $\bar{x} \pm 95\% \text{ CI}$ | $\bar{x} \pm 95\% \text{ CI}$ |
| premating-short | 18.3 ± 2.1 a* | 25.5 ± 1.6 a | 706 ± 56 a |
| premating-long | 41.2 ± 3.7 b | 48.0 ± 4.9 b | 875 ± 40 b |
| stress | 45.1 ± 7.8 b | 35.2 ± 7.2 ab | 1346 ± 109 c |

* Chirp measurements followed by different letters were found significantly different at the $P < 0.05$ level by Scheffé's test.

Stridulation of *H. rugipennis* during premating behavior was bimodal in chirp structure (Table 2) and rhythm pattern, consisting of a slow series of long chirps followed by a series of quickly trilled, shorter chirps (Fig. 1B). Thus, premating stridulation can be described as a *sentence* (Broughton 1963; Alexander 1967) with 2 distinct parts. A sequence of 2-11 long chirps ($\bar{x}=4$, $n=27$) with a rhythm of about $1\frac{1}{2}$ chirps/sec usually preceded 5-20 short chirps ($\bar{x}=12$, $n=27$) trilled at about 7 chirps/sec (Fig. 1B). Occasionally the trill was not preceded by long chirps, and long chirps sometimes followed the trill, but every male tested typically emitted the bimodal pattern. Observation of abdomen motion during stridulation showed that each long chirp in the long chirp mode, and each short chirp in the trill mode, is a train of pulses produced by 1 downward stroke of the abdomen during each cycle of stridulatory movement, i.e., a *phonatome* in the sense of Walker and Dew (1972; see also Morris and Walker 1976).

When handled, males readily emitted stress chirps (Fig. 1A) that had a faster toothstrike rate than other types of stridulation (Table 2). In the laboratory, males walking on field infested logs frequently entered holes of mated pairs ($n=20$). These intruders invariably backed out of the gallery after a few seconds, followed by the resident male. In another test, resident and intruder males never fought and were silent in 93% of the encounters (Table 1, bottom line). Such lack of aggressive behavior was also reflected in the behavior of beetles infesting spruce logs in the forest. Both sexes aggregated under bark flakes, and groups of females often were found side by side, with bodies touching, boring galleries ($n=87$). Apparently this species does not have territorial or rivalry stridulation as described for *Dendroctonus* by Rudinsky and Michael (1974).

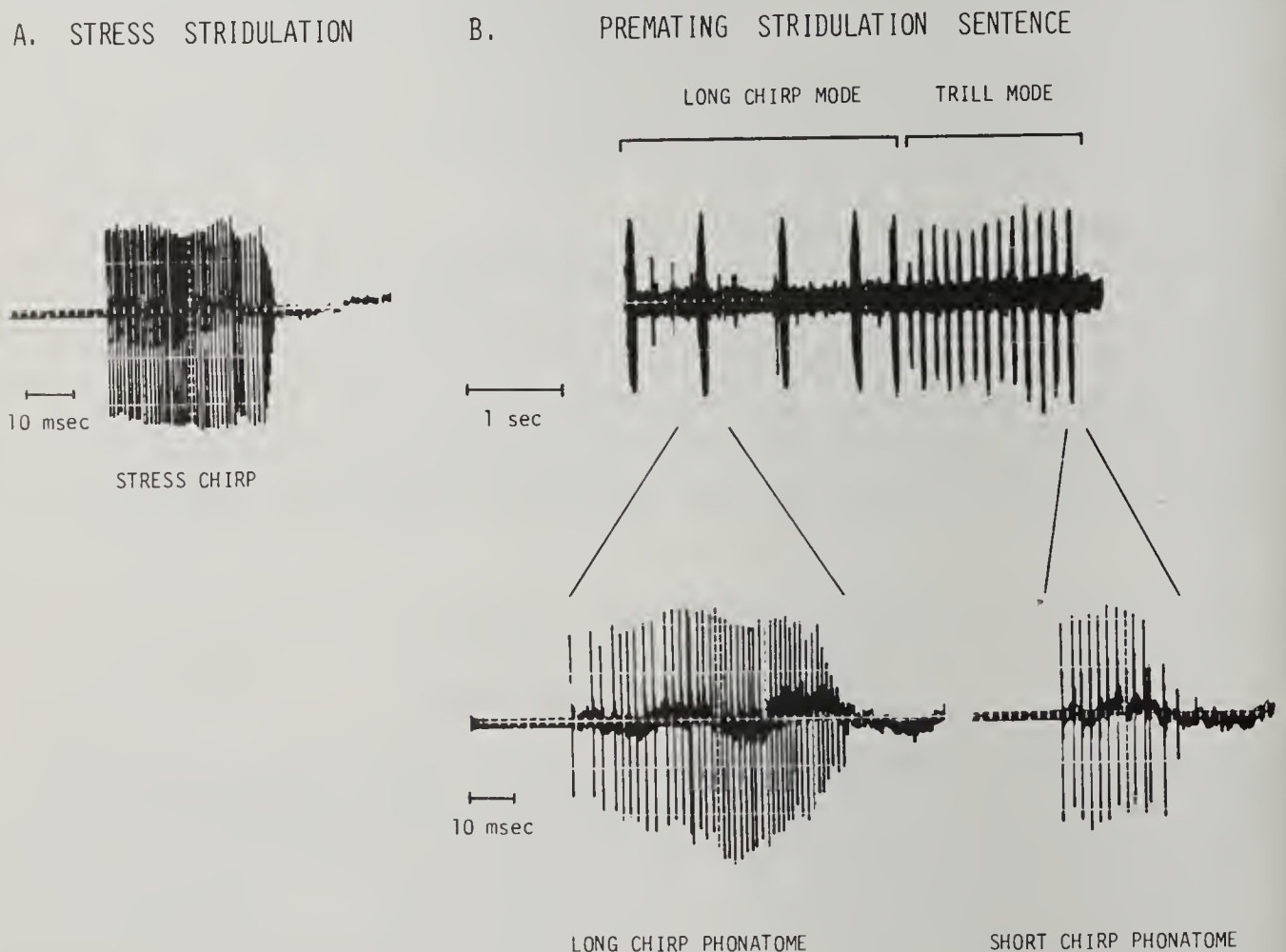


Fig. 1. Oscillograms of stridulation of male *Hylurgops rugipennis*.

The acoustic behavior of *Hylurgops rugipennis* is similar to *Dendroctonus pseudotsugae* in that males produce multi-pulse stress chirps distinct from chirps emitted during pairing. However, *H. rugipennis* is distinctive in its bimodally patterned male pre-mating stridulation, and its lack of rivalry stridulation or aggressive behavior.

The bimodally-patterned stridulation emitted by *Hylurgops rugipennis* during pairing is qualitatively different from the attractant chirp of *Dendroctonus* because *Dendroctonus* will stridulate in response to attractive frass in the absence of the female, whereas *Hylurgops* emitted bimodal sentences only when the female was present. The possibility that *H. rugipennis* would stridulate in response to a female without her frass was not eliminated by these tests. However, it is clear that bimodal chirps of *H. rugipennis* are pre-mating, but not the special case of pre-mating which was designated as attractant stridulation. *Hylurgops rugipennis* is not known to infest living trees and does not require a highly synchronized mass attack. The smaller repertoire of acoustic communication of *Hylurgops* is consistent with a generality that species that do not quickly aggregate to overwhelm living trees have a less complex and refined system of chemical and acoustical communication.

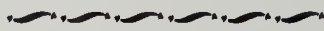
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BOOK NOTICES

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- The role of arthropods in forest ecosystems**, edited by W. J. Mattson. 1977. Springer-Verlag New York Inc., 175 Fifth Ave., N.Y., NY 10010. Hardbound, 104p., \$15.80.
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